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U. S. DEPARTMENT OF AGRICULTURE

FOREST SERVICE

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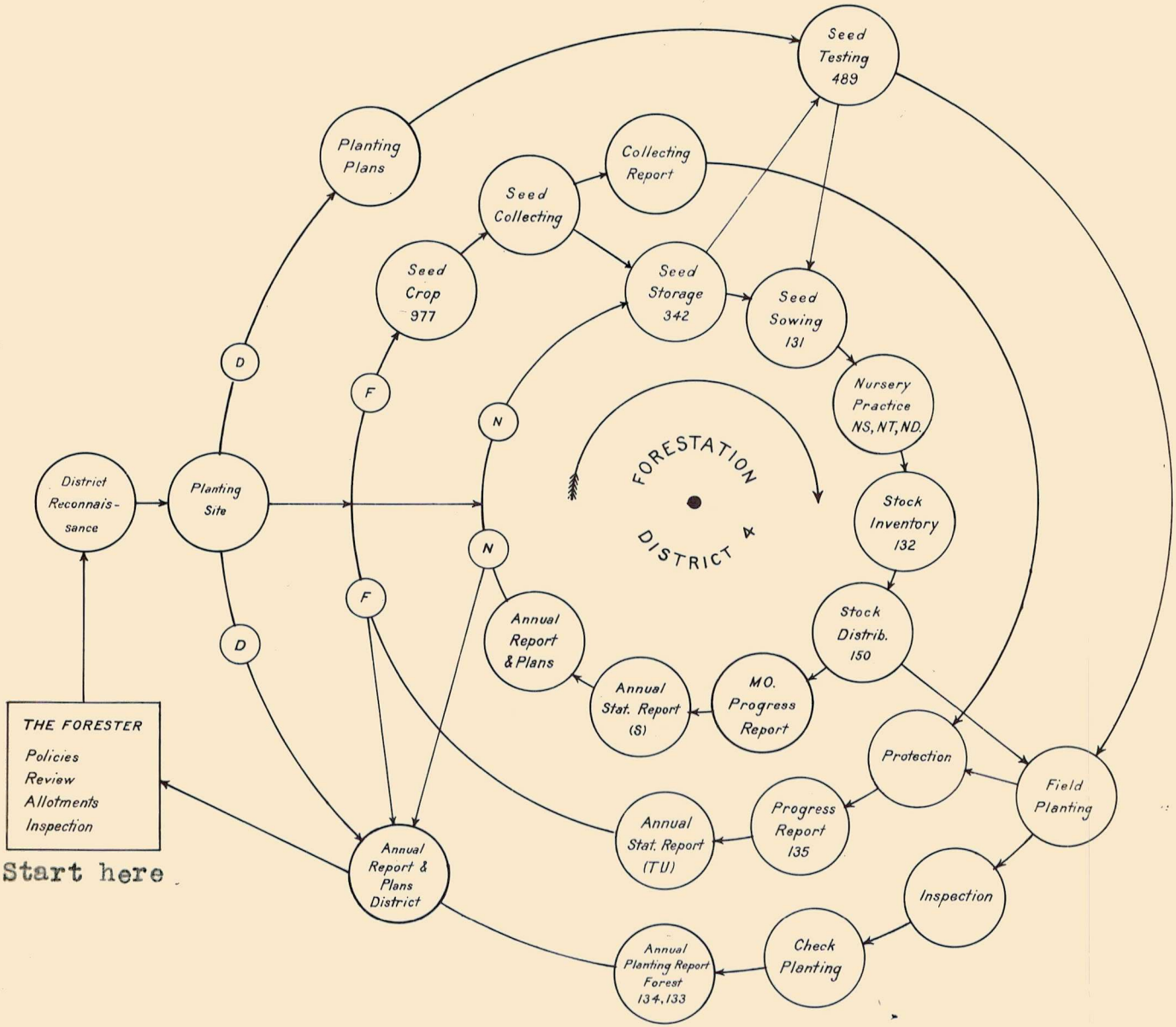

ROUTING OF FORESTATION ACTIVITIES AND RESPONSIBILITIES

DISTRICT 4, 1917

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U. S. DEPARTMENT OF AGRICULTURE

DIVISION OF FORESTRY,

Circular No. 1.

Washington, D. C. April 5, 1886

Dear Sir:

Allow me to call your attention to the necessity for all concerned in the public welfare of giving serious thought to the growing importance of the forestry question to the country as a whole and to the individual States. I trust that the warning voices pointing out the dangers to the welfare of the country, arising from an indiscriminate destruction of forests without adequate provision for their restoration, have been heard by you, and also the suggestion that, in order to arrest the tendency to wastefulness in this particular, it is necessary to look first of all to the aid of public schools and other means of education.

To show that the subject is a serious one, considered only from a material point of view, let me submit to you a few striking figures which seem to approximate the state of affairs as arrived at in the preliminary investigations carried on by this Department.

The forest area of the United States seems to be less than 450 million acres, of which more than 10 million acres yearly are destroyed by fire, and to supply the needs

of fuel, ties, lumber, etc., it is estimated that certainly not less than 10 million acres are denuded, altogether an area of over 60,000 acres per diem, the product representing a value of more than $700,000 per annum.

The consumption of the forests in supplying our railroads with ties in enormous and increasing with the rapid extension of the roads. It is estimated that the building of existing roads has taken the available timber from an area as large as the States of Rhode Island and Connecticut, and that to keep them in repair by replacing decayed ties with new ones requires annually the yield of more than 500,000 acres.

In 1853 the forest area of Ohio was 55.27 per cent. of the area of the State. In 1881 it was but 22.57 per cent. A similar rapid consumption of the forests has taken place in other States. In many cases the flow of streams has been lessened or made irregular by the removal of the forests from their vicinity. Floods and droughts have become frequent and destructive from the same cause, and agriculture and manufacturers have suffered greatly in consequence. The consumption of the forests so far exceeds their growth that, if no effective measures are taken to check the decline, the forests would entirely disappear within a hundred years. The great pine forests of the northwest will hardly last till the close of the present century.

I will only allude to the more complicated and

sometimes disputed influences which the forest exert upon the agricultural and hydrological conditions of its surroundings. Your acquaintance with the history of older nations and the observations recorded on this continent will convince you that this is at least a subject which requires serious attention.

This Department in its Forestry Division has been charged to obtain such information as may form a basis for intelligent action, and to exert, by the diffusion of accurate knowledge on the subject and otherwise, its influence in leading to a reform in the present methods of using the forests and to secure their renewal.

This most desirable work, however, is only inadequately provided for by the appropriation given by Congress for the purpose. And the difficulty of obtaining precise and reliable information as to actual conditions and needs is great.

Knowing that there is no body of men in the country, as a class more intelligent and more capable of aiding this important work, nay more interested in it, than the educators of the coming generation, perceiving also that the two purposes of obtaining and diffusing information for which this Forestry Division was constituted are subserved at one and the same time by the following plan, I would respectfully ask your consideration and support of the same.

It is proposed--

1st. To engage the force of teachers under

your superintendence upon the ascertainment of facts in regard to forest areas, their distribution, utilization, etc., in their immediate precincts.

2nd. By thus directing their attention to the subject and supplying them with such information as the Department may be able to give in regard to forestry, to have their own and their pupils' interest excited, and thus by direct influences to arouse a desire to understand the questions involved.

It is not proposed to introduce a new branch into the course of studies, but simply to create a moral sentiment which will do its share in enlarging the views of these soon to become citizens.

Nor is it believed that such work, properly laid out and directed from here, will involve much time or undue attention on the part of the teachers, but while bringing them into sympathy with a national undertaking will afford them not only pastime and recreation but the consciousness of performing an important duty of citizenship.

Awaiting your favorable consideration of this plan,

Respectfully,

B. E. Fernow,

Chief of Division.

U. S. DEPARTMENT OF AGRICULTURE

FORESTRY DIVISION

Circular No. 2

Washington, D. C. ____ 1887.

A Circular to Educational Men.

The Forestry Division of the Department of Agriculture, primarily created to promote a popular understanding of the vital interests which are centered in the forest wealth of the United States, has directed its principal effort hitherto towards investigating the conditions of the forest areas of the country, and the rapid decrease of the most valuable sources of supply, and has shown the need of inaugurating a new system of forest management and reproduction, by which alone the perpetuation of an ample supply of forest products, so vital to national prosperity, can be secured.

The array of statistics collected and reported already by this agency should suffice to awaken greater popular interest in the solution of so momentous a national problem than has thus far been manifested.

Hitherto we have destroyed our forests for the sake of immediate pecuniary gain or convenience, with reckless disregard of consequences or of the future supply of a material so valuable and even necessary for almost all pursuits and for the comfort of all classes. The history of other countries, which by the denudation of their forests

have lost their agricultural fertility and which have suffered also from great climatic changes, should be sufficient warning to an intelligent people like ourselves to guard against a similar experience by taking measures in season to arrest the course of destruction which has prevailed and to adopt a system of wise forest conservation.

In marking out the line of future work to be undertaken by the Division of Forestry, the Commissioner of Agriculture deems it of great importance that those to whom the shaping of the intelligence of the coming generation is intrusted should be specially invited to take a calm consideration of this long-neglected subject.

Schools of every grade, without departing at all from their proper work, can supply some practical lessons in regard to the object and use of forests, the nature and growth of trees, and the significance of their existence or absence, awakening thereby the interest of pupils in a kind of knowledge too little fostered in the schools of the agricultural classes.

In schools of the higher grade it can be united with instructions in botany and natural history in general. In colleges forestry should be presented in lectures on its various relations to arboriculture, agriculture, and political economy.

Engaging thus the popular and higher education, we may establish a popular system of forestry suited to the peculiarities of our country and its people. We shall foster

at the same time sympathy with rural objects, which will tend to make our youth content with rural life, instead of being overcome by the attractions of the great cities.

The Commissioner calls special attention to the value of object-lessons in any branch of study, and recommends to all heads of the higher educational institutions, as far as in their power, to cause the grounds of their respective institutions to be planted with collections of forest and ornamental trees and shrubs, grouped in accordance with their botanical relations or with a view to successful growth by a system of judicious mixing of kinds for mutual protection.

A general adoption of this recommendation would soon convert the much neglected grounds surrounding our colleges and schools into park-like groves of great attraction, the exponents of correct taste in ornamental planting, and perpetual volumes of forest botany and arboriculture.

In like manner might the study of botany be promoted and popularized by the culture of representative kinds of plants united in accordance with their systematic relationship. Botanical parterres of plants, both economic and ornamental, might easily be introduced into the school grounds of the country, through which much useful information, both practical and scientific, would be imparted, assisting rural life in its onward course to a higher plane of culture.

The Commissioner will take pleasure in promoting the adoption of his recommendation, as far as in his power, by contributions of plant material, and has especially instructed the western agent of the Forestry Division, Prof. M. C. Kern, of St. Louis, Mo., a professional landscape-gardnner, to correspond with all who desire further information or advice in the design and improvement of the grounds of Educational Institutions.

If this recommendation meets with your favor, and you desire to avail yourself of the proffered aid, please fill out the inclosed blank and return it with your reply.

Respectfully,

(Signed) NORMAN J. COLMAN,
Commissioner of Agriculture

U. S. DEPARTMENT OF AGRICULTURE

FORESTRY DIVISION

Circular No. 3.

INFORMATION TO WOOD CONSUMERS

Increasing the Durability of Timber.

Our people waste a large amount of timber and of labor, by lack of care for the timber, after it is cut. Rotting of timbers and fence posts necessitate not only the cutting of a large quantity of wood but also the labor of replacing the same oftener, than if the wood could be made to last longer.

There are some rules in the handling of timber, which are too often overlooked and which should be observed by everybody, who uses wood in places where it cannot be kept dry or wholly submerged.

There is also much unintelligent use of paints and other coatings, applied in the hope of preserving timber, when it should have been well known, that by painting green or badly seasoned timber, decay is hastened rather than prevented.

While to many it may be impossible to apply the more complicated and expensive methods of wood preservation which recommend themselves to large consumers of wood material, knowledge of the following considerations, suggested

by the Chief of the Forestry Division, will aid the small consumer to handle his material to better advantage, to utilize forest products more thoroughly and intelligently, and to make them last from two to three times as long as when not observed.

Decay of Wood

1. Decay of wood is due to formentation of the sap, induced probably by the growth of either bacteria or fungi. These organisms need for their development warmth and moisture, besides the nitrogenous substances and salts contained in solution in the sap.

To prevent the growth of these ferments, therefore, the sap in the wood must be dissolved (leeched) or dried out, and moisture be prevented from entering again.

The Manner of Use Influences Durability of Timber

2. Timber placed entirely under water or deep in soil (drain pipes) will practically not decay, nor is it liable to rot, when kept absolutely dry, away from the influence of humid atmosphere.

Wood generally decays in proportion to the warmth of the temperature.

Hence on northern exposures, in cool valleys, on high elevations in northern countries, the duration of wood is longer than when placed under opposite influences.

If wood is used in contact with the ground, decay

proceeds the more rapidly, (beginning at the point of contact with the soil) the looser, moister, and warmer the soil, and especially the greater the liability of change from dry to wet; therefore timber will last longer in heavy, always moist clay, than in loose, alternately moist and dry sand or gravel, or in warm, comparatively dry lime soils.

Rooms without ventilation induce decay, producing the dry-rot (which first appears in white patches changing into brown or gray). Ventilation, drying-out, and isolation from moisture will cure this defect.

Natural Factors Influencing Durability

3. Sound trees yield more durable timber than either young or very old trees. Maturity is the time when trees have ceased to grow vigorously, which is indicated by a flattening of the crown, dying-out of branches in the crown, and by the change of color of the bark. Maturity may be reached, according to circumstances, by the same species, when the diameter is only a few inches or when it is as many feet. The small tree on arid soil or overtopped by others from its birth, may be as old and older than a tree of greater dimensions growing under more favorable conditions. Of two pieces of the same kind the heavier is the more durable, although absolute weight of two different kinds of timber, does not determine their relative durability.

Heart-wood, as a rule, can resist deterioration longer than sap-wood, because it contains less sap; but, when the sap-wood is well seasoned and heavier, this difference disappears.

The site has an influence on durability in so far as it influences the formation of heavy wood.

Quickly-grown hard-woods with wide annual rings, and slowly-grown conifers with narrow (yet not too narrow) rings, and "tapped" pines (on the tapped side) yield, as a rule, the most durable wood, other conditions being equal.

Conifers wood from comparatively poor soils, high altitude, and dense forest, hard-woods from rich deep warm soils and isolated position, are most durable.

The resinous substances in conifers form an element of protection against decay.

4. The following list of trees comprises most of those of common occurrence which have been found to be the most durable. Without means of determining the exact relative value of the different species, it has been possible only to give a series which in general proceeds from the most durable to less durable ones.

Eastern Range

Conifers: red cedar, Juniperus virginiana, L.; white cedar, Chamaecyparis sphoeroides, Spach.; arborvitae, Thuya occidentalis, L.; bald cypress, Taxodium distichum, Rich.; long-leaved pine, Pinus palustris, Miller; red pine, Pinus resinosa, Ait.; Cuban pine, Pinus Cubensis, Grisch.;

short-leaved, Pinus mitis, Michx.

Broad-leaved Trees: white oak, Quercus alba, L.; post oak, Quercus obtusiloba, Michx.; basket oak, Quercus michauxii, Nutt.; bur oak; Quercus macrocarpa, Michx.; chestnut oak, Quercus prinus, L.; live oak; Quercus virens, osage orange, Maclura aurantiaca, Nutt.; hardy catalpa, Catalpa speciosa, Warder; black locust, Robinia pseudacacia, L.; honey locust, Gleditschia triacanthos, L.; red mulberry, Morus rubra, L.; chestnut, Castanea vulgaris, var. Americana, A.D.C.

Rocky Mountain Region

Red cedar, Juniperus virginiana, L.; pinyon pine, Pinus edulis, Engelm.; Fox-tail pine, Pinus balfouriana, Murray; Douglas spruce, Pseudotsuga douglasii, Carr.; western larch, Larix occidentalis Nutt.; bur oak, Quercus macrocarpa, Michx.

Pacific Slope

Yew, Taxus brevifolia, Nutt.; redwood, Sequoia sempor-virens, Endlicher; Lawson's cypress, Chamaecyparis lawsoniana, Parl.; canoe cedar, Thuya gigantea, Nutt.; Douglas spruce, Pseudotsuga douglasii, Carr.; western larch, Larix occidentalis, Nutt.; live oak, Quercus chrysolepis, Liebm.; post oak, Quercus garryana, Dougl.

Time of Felling

5. With proper after-treatment of the wood the time of felling seems not to affect its durability. Early winter felling (December) should have the preference, because less fermentable sap is then in the trees, and the timber will season with less care, more slowly and more evenly, and before the temperature is warm enough for fermentation to set in.

If the wood is cut "in the sap" it is more liable to fermentation and to the attacks of insects, and more care

is necessary in seasoning; for the rapid seasoning, due to the warm dry atmosphere, produces an outer seasoned coat which envelopes an unseasoned interior liable to decay. When cut in the leaf it is advantageous to let the trees lie full length until the leaves are thoroughly withered (2 or 3 weeks), before cutting to size. With conifers this is good practice at any season, and if it can be done, all winter-felled trees should be left lying to leaf out in spring, by which most of the sap is worked out and evaporated.

Treatment after Felling

6. Always remove the bark from felled timber to aid seasoning--but not from the standing tree.

Never allow the log to lie directly on the moist soil.

If winter-felled, shape the timber to size within two weeks after felling and leave it placed on blocks--not upon the soil-- in the forest, or if shaped at home place in a dry, airy--not windy--position away from sun and rain.

If dried too rapidly, wood warps and splits, the cracks collect water and the timber is then easily attacked and destroyed by rot.

With large logs checking may be prevented by coating the ends with some fatty or oily substance mixed with brick dust, or covering with a piece of linen, cloth, or even paper, or by simply shading them to lessen evapora-

tion; cracks on the sides may be filled in with tow or cotton.

When piling timber, place laths or sticks of uniform size at uniform distances under each log, or post, or tie.

Sufficiently thorough seasoning for most purposes is obtained in 12 to 18 months, while for special work, according to the size, from 2 to 10 years is required.

The best method for obtaining proper seasoning without costly apparatus in shorter time, is to immerse the prepared timber in water, from one to three weeks, to dissolve the fermentable matter nearest the surface. This is best done in running water--if such is not at hand, a bath may be substituted, the water of which needs frequent change. Timber so treated, like raft timber, will season more quickly and is known to be more durable.

If practicable the application of boiling water or steam is an advantage in leeching out the sap.

Coatings to Keep Out Moisture

7. Never apply paint or any other coating to green or unseasoned timber.

If the wood was not well dried or seasoned, the coat will only hasten decay.

Good coatings consist of oily or resinous substances which make a smooth coat, capable of being uniformly applied; they must cover every part, must not crack, and possess a certain amount of plasticity, after drying.

Coal-tar, with or without sand or plaster or pitch,

especially if mixed with oil of turpentine and applied hot, (thus penetrating more deeply) answers best. A mixture of 3 parts of coal-tar and one part clean unsalted grease, to prevent the tar from drying until it has had time to fill the minute pores, is recommended. One barrel of coal-tar (3 to $4. per barrel) will cover 300 posts. Wood-tar is not serviceable because it does not dry.

Oil Paints are next in value. Boiled linseed oil or any other drying vegetable--not animal--oils, are used with lead or any other body (like pulverized charcoal) to give substance. Immersion in crude petroleum is also recommended.

Charring of those parts which come into contact with the ground can be considered only as an imperfect preservative, unless a considerable layer of charcoal is formed, and if it is not carefully done, the effect is often detrimental, as the process both weakens the timber and produces cracks, thus exposing the interior to ferments.

Lastly, in communities where durable timber is scarce it will pay to establish a plant for impregnating timber with antiseptics by the more costly processes described in Forestry Bulletin No. 1.

NORMAN J. COLEMAN,

Commissioner of Agriculture.

U. S. DEPARTMENT OF AGRICULTURE

FORESTRY DIVISION

Circular No. 4.

FOR INFORMATION OF RAILROAD MANAGERS

Washington, D. C. December 1887.

Gentlemen:

Hoping that you have appreciated the manner in which the Forestry Division of this Department has, by its first Bulletin, attempted to call the attention of Railroad managers to the need of economy in the use of forest supplies, allow me, in furtherance of such economy, to present the following statements, which may be of interest to you.

In the use of oak for cross-ties, the specifications of most roads, especially those of the South, call for white oak (Quercus alba), a timber which is sought for also by almost every industry employing oak, and which is therefore rapidly decreasing and approaching comparative exhaustion. Meanwhile, millions of feet of tan-bark or chestnut oak (Quercus prinus) are rotting in the forests, after being stripped of their bark, because their value for cross-ties is not known or is underestimated in many regions.

This lack of appreciation of the value of this wood causes not only waste of the wood itself, but waste

of the bark also, as without ready demand for the wood, it does not pay to peel the larger limbs.

From information furnished by Dr. Mohr, of Mobile, Alabama, an expert in forestry statistics and agent of this Department, it appears that from the line of the Louisville and Nashville Railroad, south of the Tennessee River, between 5,000 and 7,000 cords of bark are shipped annually, involving the felling in that district alone of from 10,000 to 13,000 trees which are consigned to useless destruction, while capable of yielding not less than 100,000 first-class railroad ties.

As to the lasting quality of the timber of chestnut oak experiences are reported from Cullman, Alabama, to the effect that posts of this oak outlast those made of white oak, partly probably because the timber is peeled. One reliable report states that tan-bark oak posts were found to be sound after twelve years, while those of white oak in the same construction had to be replaced several years sooner. Reports from Railroad Companies, where this wood is used for ties, give their life as from 5 to 10 years, while the reports for white oak give from 3 to 12 years. In the average, all the oaks which are known as "white oaks", named below, last between 7 and 8 years in the road-bed.

That the oaks of this class may be used for railroad construction interchangeably, and do not offer any appreciable differences in the qualities most essential

for a good railroad tie, the following table, compiled from the Census Report, may serve to show. The column of specific gravity will allow an estimate in regard to adhesion of spikes, while the column of indentation allows an estimate as to resistance to cutting of rail. The position as to quality, in comparison with the other kinds mentioned, is indicated by numbers in parenthesis.

	Range	Weight per cu. ft.	Specific Gravity	Resistance to indentation	Elasticity	Transverse strength
White oak, Quercus alba, L.	East of the Rocky Mountains	46.35	0.7470(4)	3388(6)	97089(2)	905(4)
Chestnut or rock-chestnut oak, Quercus prinus, L.	Northeastern addition: Kentucky, Tennessee, and Alabama	46.73	0.7499(3)	3688(5)	125473(1)	1031(2)
Basket or cow oak, Quercus michauxii Nutt.	South-eastern	50.10	0.8039(2)	3725(4)	96373(3)	1118(1)
Bur, Mossy-cup, or over-cup oak, Quercus macrocarpa, Michx.	Northern U. S.	46.45	0.7453(6)	3730(3)	92929(4)	982(3)
Post or iron oak, Quercus obtusiloba, Michx.	East of Rocky Mountains	52.14	0.8367(1)	4415(1)	83257 (5)	872(6)
California white oak Quercus garryana, Dougl.	Pacific Coast	46.45	0.7453(5)	3846(2)	81109(6)	879(5)

From these figures it would seem, that contrary to the accepted notion, the white oak, PAR EXCELLENCE, is inferior in all particulars to the chestnut oak, and in general not superior to any of the others.

Trusting that the above information will be of value to you, and that, so far as your conditions enable you to make use of it, you will do so, and thus to some extent aid in economizing timber supplies.

Yours respectfully,

NORMAN J. COLMAN,

Commissioner of Agriculture

UNITED STATES DEPARTMENT OF AGRICULTURE

FORESTRY DIVISION

Circular No. 5.

ARBOR DAY PLANTING IN EASTERN STATES.

The following Circular has been prepared to answer inquiries from School Superintendents and other officials as well as private individuals who are interested in tree planting on Arbor Day.

J. M. RUSK,

Secretary.

Sir:- I have the honor to submit herewith a circular giving brief instructions on selection of trees and manner of planting for Arbor Day purposes, to answer inquiries from school superintendents and others interested in Arbor Day.

Respectfully,

J. M. Rusk,
Secretary.

B. E. FERNOW,
Chief of Forestry Division.

INTRODUCTORY:- Arbor Days in the Eastern States as a rule contemplate the planting of shade and ornamental trees mainly for the sake of creating a sentiment and interest in tree planting and eventually in forest culture.

The following suggestions do not refer to the educational features of Arbor Day, but are meant to give in the briefest manner such general advice in regard to the selection of trees for the occasion and to the manipulation of planting, as may aid teachers, pupils and others to perform the practical work of Arbor Day with reasonable hope of success.

TIME OF PLANTING.- The day set for Arbor Day and the weather on that day may not always be the best for planting. Its fitness for an out-door celebration, should govern the choice, while the planting may be done at a more suitable season. Spring, before the buds open (February or May) is as rule the best time for transplanting - although with care it can be done all the year round - and a murky or cloudy day is preferable to a sunny one for that operation.

CHOICE OF TREES.-

1. General Considerations.- Trees for school grounds and yards, along roadsides and streets, must be such as are least liable to suffer from injuries; they should be compact and symmetrical in shape, free from objectionable habits, such as bad odors, root-sprouting, frequent dropping of parts, etc., and from insect pests, and if planted for shade, should have a broad crown and a dense foliage, budding early in the spring and retaining leaves long into the fall. Absence of skillful hands at tree-planting on Arbor Days would also limit the selection to those which are transplanted easily and require the least care.

Trees native to the region in which the planting is done usually have more promise of success and are generally less costly than exotics. Trees from well managed nurseries are preferable to those grown in the forest, because their root-system is better prepared for transplanting. Rapidly growing trees, although giving shade soonest, are mostly shortlived and become soonest unsightly.

2. Size. - Although as a rule small plants have a better promise of success, other considerations recommend the choice of larger sizes for roadside and ornamental planting. Trees of any size can be successfully transplanted, but in proportion to the size grows the difficulty, the amount of work and the care necessary. As a rule the largest size should not exceed 2 to 3 inches in diameter at the base and 10 to 15 feet in height. Those one-half that size will probably make better growth, because less of their root-system will be curtailed in taking them up for transplanting.

3. Diagnosis of a tree suitable for transplanting:-

a. An abundance of fibrous roots. Not the turnip-like main or tap-root but the little fibres sustain the life of a tree. See that there are plenty of them, compactly grown within a small compass, and that they are not stripped of their bark or torn at their ends or dried up.

b. A normal form and well proportioned development of shaft and crown. The shaft should be clean and straight, neither

thick set and short, nor thread-like and over elongated, but gradually tapering and strong enough to hold up its head without support. The normal crown is characterized by vigorous full sized leaves, or else by a large number of thick and full buds; it covers the main stem one-third to one-half its length, with a symmetric spread evenly branched, and has only one leader, of moderate length.

The length and vigor of the last year's shoots, number and thickness of buds, and the appearance of the bark afford means of judging the healthy constitution of the tree.

c. The position from which the tree came has some influence on its further development. Trees from the forest have generally a wide spreading root-system, which is difficult to take up and transplant. Those which have grown in the shade of the forest as a rule do not start easily in the open sunlight; those from cool north sides are apt to sicken when placed on hot exposures and vice versa. A healthy tree from poor soil transferred into better conditions will show itself grateful by vigorous development.

TREATMENT BEFORE TRANSPLANTING .- Transplanting is at best a forcible operation, and injury to the roots, although it may be small, is almost unavoidable. The roots are the life of the tree, and need, therefore, the most attention. In taking up a tree for transplanting the greatest care must be exercised to secure as much of the root-system intact as possible, especially of the small fibrous roots.

a. Never allow roots to become dry, from the time of taking up the tree until it is transplanted. - A healthy looking tree may have the certainty of death in it if the root fibrils are dried out. To prevent drying during transportation, cover the roots with moist straw or moss orbags, or leave on them as much soil of the original bed as possible. At the place where the tree is to be planted, if the planting cannot be done at once, "heel in" the roots, i. e., cover them and part of the lower stem with fresh earth, or place the tree in the plant hole, throwing several spadeful of earth on the roots.

b. Pruning roots and branches is almost always necessary, but must be done with great care, especially as to root pruning. The cutting at the roots should be as little as possible, only removing with a clean sharp cut the bruised and broken parts. Extra long tap-roots may be cut away, but all the small fibers should be preserved. The cutting at the top is done to bring crown and root into proportion; the more loss at the root-system has been experienced the more need of reducing the crown system. Larger trees, therefore, require mostly severe pruning, especially on poor soils; yet if there be fibrousroots enough to sustain great evaporation from the crown, the less cut the better. With large trees severe pruning is less dangerous than too little. A clean cut as close as possible to the stem or remaining branch will facilitate the healing of the wound. No stumps should be left (except with conifers, which suffer but little prun-

in-). Shortening of the end shoots to 1/2 or 2/3 of their length may be done a little above a bud which is to take the lead. As a rule, the pruning for symmetry should have been done a year or so before transplanting, but may be done a year after.

METHOD IN PLANTING A TREE.- Holes are best made before the trees are brought to the ground. They should be a little deeper than the depth of the root system, but twice as large around as seems necessary, to facilitate penetration of rains and development of rootless through the loosened soil. Place the top soil, which is better (being richer in easily assimilated plant food) to one side, the raw soil from the bottom to the other side; in filling back bring the richer soil to the bottom. If it be practicable, improve a heavy loamy soil by adding to and mixing with it looser sandy soil, or a loose poor soil by enriching it with loam or compost. Keep all stones out of the bottom; they may be used above the roots, or better, on the surface. Providing proper drainage is the best means of improving ground for tree planting. Use no manure except as a top dressing.

2. Planting is best done by two or three persons. A, who manipulates the tree is the planter and responsible for the results; B and C do the spading under his direction. A, places the tree in the hole, to ascertain whether this is of proper size; a board or stick laid across the hole aids in judging the depth. Trees should not be set deeper than they stood before, except in loose, poor soil. More trees

are killed by too deep planting than the reverse. If the root-system is developed sideways but not centrally, as is often the case, a hill is raised in the hole to fill out the hollow space in the root-system, and the earth of the hill is patted down with the spade. When the hole is in proper order, A, holds the tree perpendicularly in the middle of the hole, with the side bearing the fullest branches toward the south, or southwest, for better protection of the shaft against the sun. B and C spread the roots into a natural position then fill in the soil, using the good soil first- small spadefuls deliberately thrown over the roots in all directions - while A, by a slight shaking and pumping up and down of the stem, aids the earth in settling around the rootlets. A close contact of the soil with the rootlets is the secret of success in planting. Only fine mellow soil, not too moist, and free from stones, will permit such close adjustment to the rootlets, which should also be aided by hand and fingers filling in every crevice. A, while setting the tree, must exercise care to keep it in proper position and perpendicular, until the soil is packed so as to keep the tree in place; then B and C rapidly fill the holes, A treading down the soil firmly after a sufficient quantity is filled in, finishing off a little above the general level to allow for settling, and finally placing the stones or any mulching around the stem.

WATERING.- The practice of using water while planting

can hardly be said to be a good one, unless the water is very carefully applied with a "rose" after the soil is well filled in and packed around the fibrous roots. Especially with a soil which has a tendency to clog, there is great danger of an uneven distribution and settling, with consequent empty spaces between the roots. More trees are probably killed by too much water in transplanting than by too little. Water after the transplanting, (andaperhaps before the last shovels of earth, are filled in) especially if the soil was dry, is useful and should be applied during the hot season, choosing the late afternoon or evening for applying it.

AFTER CARE.- Any mulch of waste material, hay, straw, or litter, wood shavings or chips, sawdust, or even stones, simply placed around the foot of the tree, is of excellent service in checking evaporation.

Keeping the ground free from weeds and grass, and preventing it from baking, by occasional hoeing and raking, is advisable. To prevent the trees from being swayed by the wind, if of larger size, they should be staked firmly; a loose post is worse than none. The tying should be so done as not to cut or injure the tree; a tree-box insures more safety against accidents. With the development of the crown it becomes necessary to trim it, so as to carry the top above reach. Trees are not benefitted by being used as hitching posts, or climbing poles, or other frolic.

Summarizing the elements of success in tree-planting they are:

1. Trees suitable to soil and surrounding conditions;
2. A well developed root-system, kept in living condition;
3. Wide holes and mellow soil;
4. Firm packing of soil around the roots.

CHOICE OF KINDS:- Leaving out conifers- which require more careful handling and better situations than are as a rule to be had on occasions like that in view-there are over hundred indigenous species to choose from for planting on the Atlantic side; of these 30 to 40 might deserve attention for Arbor Day tree-planting, according to climate, soil and situation, or object. It is best to limit the choice for this occasion to trees of recognized merit native to your locality; opportunities will vary the choice. It is only possible here to name the following selections, which admit of a wide application in the Atlantic States.

Three trees to be planted where nothing else will grow; easily trnnsplanted, growing rapidly, but short-lived, liable to injuries, root-sprouting, soon scraggy looking unless specially attended:

Silver Maple (Acer dasycarpum) Carolina Poplar (Populus monilifera) Box Elder (Negundo aceroides)

Four trees, among the best for street and lawn:

Sugar Maple (Acer saccharinum) Red Maple (Acer rubrum) Linden (Tilia Americana) Elm (Ulmus Americana

Five trees desirable for lawn and yard:

Tulip Tree (Liriodendron tulipifera) Red Oak (Quercus rubra) Willow Oak (Quercus phellos)

Black Cherry (Prunus serotina) Sweet Gum (Liquidamber styraciflua)

Six trees suitable for special positions:

Sycamore (Platanus occidentalis)	Black Birch (Betula lenta)	Ash (Fraxinus Americana)
Black Walnut (Juglans nigra)	Chestnut (Castanea vesca)	Beech (Fagus ferruginea)

Two foreigners of note:

Horse Chestnut. (Aesculus Hippocastanum) and Paulownia (Paulownia imperialis).

UNITED STATES DEPARTMENT OF AGRICULTURE.

FORESTRY DIVISION

(Circular No. 6)

INSTRUCTIONS FOR GROWING TREE SEEDLINGS.

The following circular has been prepared to accompany the customary distribution of tree seeds from this Department. It is hoped that the instructions will be followed by the recipients to the advantage of the plant material thus distributed.

J. M. RUSK,

Secretary.

Sir:

I have the honor to submit herewith a circular giving briefly such information in regard to raising forest trees seedlings from seed as appears essential for a proper performance of the manipulations involved. Failures are very often due to ignorance of the objects which are to be attained by following instructions.

While much must be left to the good judgment of the planter in the application of instructions, a knowledge of the principles underlying his practice will safely guide him. As far as the limited space of a circular permits these objects and principles have been elucidated.

It is desirable that these instructions be placed

at least in the hands of those who receive tree seeds from the Department.

Respectfully,

B. E. FERNOW,

Chief of Forestry Division

Honorable J. M. Rusk,

Secretary

It may be set down as a rule, with few exceptions, that it is preferable and in the end more economical to grow seedlings in the seed-bed and nursery and transplant them, than to sow the seeds in permanent sites.

Success in growing seedlings is attained, first, by providing suitable conditions for the sprouting of the seed, and, secondly, by keeping up proper conditions for the development and growth of the seedling.

In order to know what the conditions are, the planter should have some knowledge of how the sprouting takes place and how the seedling develops and grows.

PRINCIPLES

SPROUTING.- Water, warmth and air are necessary to bring seeds to sprouting; darkness seems also to favor sprouting. To insure best results, the supply of heat and moisture must be moderate but even and constant. By keeping the earth-cover above the seed loose, sufficient air can penetrate to aid in dissolving the food materials in the seed, and the plantlet can also more easily find its way to the

surface and the light. In contact with the moist warm soil, the outer shell or seed-coat takes up water and swells until it bursts; then the embryo, (germ or little plantlet), which lies imbedded intthe seed, begins to grow, pushes downward into the ground its rootlet and upward to the light its stem and first leaves, called seed-leaves or cotyledons and plumulae (which are often different in shape from the later leaves). The quicker the sprouting proceeds, the less danger of spoiling the seed, to which it is quite liable when lying in the ground too long.

GROWTH OF THE SEEDLING.- After the seed is sprouted and the germ nourished into life by the food stored up in the seed, the seedling must now provide its nourishment from outside. This it takes partly from the soil, partly from the air. From the air, carbonic gas is taken up directly by the leaves, in which it is changed into vegetable substance under the influence of light and heat. The food materials contained in the soil must first be dissolved so that the roots may be able to take them up; for this againwater, heat and oxygen (air) are necessary. The food in watery solution is then conveyed by the roots through the stem to the leaves, which are the digesting apparatus (the stomach as it were) of the plant. Here, under the influence of light and heat, the water in which the food was dissolved is partly evaporated (transpired) and the food assimilated, used in forming vegetable substance, i. e. increasing the plant in size.

For the growth of the seedling, then, it is necessary that it should have at the roots a loose soil, rich in plant food, into which the rootlets can penetrate; water, warmth and air, in order to dissolve the plant food; and at the leaves light, warmth and air, in order to digest and transform the plant food into vegetable substance.

Transpiration from the leaves, which means giving up water to the air, is necessary to make plants grow, but excessive transpiration may kill the plants, and insufficient transpiration may keep the seedlings weak and undeveloped, or even kill them. Hot air and strong light make the leaves transpire greater quantities of water than when the air is cool or saturated with moisture and the plants are shaded. They also transpire more when the air is in motion than when it is quiet; a certain degree of circulation of air, however, is as necessary to plants as to human beings.

The main difficulty in growing seedlings is to regulate transpiration, to keep the water supply at the roots and the degree of light and heat at the top properly balanced.

Light and heat (or dry air) are the task-masters which make the leaves work, evaporating the water that is supplied at the roots. If the supply from the roots runs short, the plantlet soon exhausts itself in the endeavor of satisfying its task-masters and dries up; and even with ample supply of water the task required may be too much, and the delicate machinery of the plantlet may not be able

to work fast enough and may break down under too great a strain. On the other hand, if too much water be supplied at the roots, they are liable (with most plants) to rot. The supply of moisture at the roots must, therefore, be kept even and moderate, while the rate of transpiration may be regulated above and kept in proportion by the use of various contrivances.

SEED.- In regard to the seed, the planter should have at least the following knowledge:

Not all trees produce seed every year, and only few trees, if any, produce all perfect seed. The number of seeds in one hundred which will germinate,(percentage of germination), even in a fresh sample, varies with the kind and the year.

Some seeds lose their power of germination (sprouting) soon after ripening and must be sown at once. Such are willows, poplars, birches, elms, soft maples, etc. Others may be kept, with proper precautions, for one season (oak, chestnut, alder, ash, maple, linden, fir); a few can be kept alive for many years (spruce, larch, and pine). The heavier and larger seeds produce the best plants.

The different kinds swell and sprout more or less readily according to the structure of the seed-coat. Some will swell in a few hours, others will take several days, and in some seeds swelling occurs-under ordinary circumstances - only after months and years, like black and honeylocust, acacias, red bud, juniper, Kentucky coffee tree. These are called "refractory" and are said to "lie over," that is they do

not sprout readily but may lie in the ground for one or more seasons without sprouting. Some seeds become "refractory" by being kept, and their coat being allowed to become dry they lose the faculty of absorbing water readily and the swelling may be delayed a year or more (they lie over.) This is the case with ash, larch, fir, Douglas spruce, and others. Such seeds can be made to sprout more readily by soaking them in water (hot or cold) and by various other methods.

To preserve seeds in good condition the main point is to keep them cool and prevent them from drying out by mixing them with sand or in any other way.

PRACTICE.

SOIL AND SITE.- The best soil for a seed-bed is a well drained loamy sand. This is suitable for all kinds of trees and should be specially prepared if not found naturally; it may be so varied that for small and light seed there is added more sand, for heavy and large seed more loam. Manure is unnecessary, but whatever manure, compost, or sod-ashes, is used to enrich the soil must be thoroughly rotted and mixed in. The soil must be worked into thoroughly mellow condition.to a depth of 10 or 15 inches, free from stones, lumps, weeds, like the most carefully prepared garden bed.

For a small quantity of seedlings make boxes 4 to 6 inches deep, of a size convenient to handle when filled with soil, bore three or four half-inch holes in bottom

for drainage and fill with loamy sand.

The choice of a proper site for seed-bed often makes all the difference in the amount of after-care necessary and in the success. A well sheltered level spot within reach of water, with an eastern or southeastern aspect, protected against the scorching sun and drying winds by a wind-break or wall, is most suitable.

The dangers to the seed if left in the seed-bed through the winter make sowing in the spring the rule, except with those seeds which cannot be kept or are apt to spoil by keeping, and which should if possible be sown soon after ripening. Elm, soft maple, birch, are therefore sown in June; alder, hard maple, linden, fir, etc. are best sown in fall; oak, chestnut, beech, and other nuts which require much care in keeping are also often sown in fall; while conifers, which ripen late, are mostly kept till spring. Fall sowings sprout earlier in spring, and the seedlings are therefore more liable to danger from late spring frosts. Even temperature being most favorable for sprouting, the choice of time in spring varies according to the locality and the season, when the weather becomes settled. Middle of April to May is probably a mean or average time.

QUANTITY OF SEED.- The quantitiy of seed to be used on a given area, or the room needed for a given quantity of seed, depends on the size of the seed as well as on its quality. Consideration should also be given to the rapidity

of development of the seedlings and the length of time they are to remain in the seed-bed. Deciduous trees require more room the first year than conifers. The number of seeds per pound allows a fair estimate of the comparative room required, making allowance for quality. (Poor seed and of kinds which produce much immature seed, like elm and larch, must be sown more thickly.) The number of lineal feet of drill per ounce of seed varying of course according to quality of seed, may be roughly stated as follows: Ash, maple, honey locust, cherry, and similar seeds 20 to 25 feet drill per ounce; catalpa, elm, alder, birch, etc., 40 to 45 feet; pines (very variable in size) and spruces from 30 to 60 feet, mostly the latter; firs with a small per cent, of germinating seed may be sown as thick as 1 ounce to 10 feet of drill, and larch, 1 ounce to 25 or 30 feet. Black locust, with a high per cent. of germination and vigorous development the first year, not less than 40 feet; one pound of chestnuts, acorns, hickory nuts, will require 10 to 12 feet drill; 1 pound of walnuts may require 5 feet.

METHOD OF SOWING.- Sowing in drills is preferable to broadcast sowing, because it can be done more even and the plants can be more easily cared for by weeding, loosening the soil, mulching, thinning out, as well as more readily moved for transplanting.

A distance between the drills of 4 inches is sufficient for conifer seedlings remaining one or two years in the seed-bed; deciduous tree seeds, which develop rapidly during

the first year, require a distance between the drills of 9 to 12 inches.

As to width of drill, one seeded so as to produce a single row of plants is preferable to a broader drill with many plants; although more plants are grown on the same space in the latter case, they are as a rule not as strong and vigorously developed.

Make drills across the bed by pressing the soil down with the edge of a lath or board of proper width, or for deeper drills, with a stick or hoe or other suitable tool.

In sowing, a piece of cardboard bent at right angle or a trough made of two light strips of wood nailed lengthwise at right angle will do service in evenly distributing the seed.

The depth of the drill, or what is the same the depth to which the seed is to be covered, depends on the size of the seed.

The object of covering the seed, besides excluding the light and as a protection against the birds, etc., is to prevent the drying out of the seed and later of the plant germ as it pushes up. The covering must be thin enough to allow the air to penetrate to the seed, and the germ to push through to the light. Better too little than too much cover. Too much cover is the death of many seeds, and at least results in retarding germination, smaller number and weaker plants.

The following are the maximum depths to which the seeds mentioned may be covered with loose soil, and which may

serve as guide for other seeds:

Oak, chestnuts 1½ to 2½ inches; maple ½ to ¾ of an inch. Black locust (an exception to the rule) will stand and produce best results with a cover of 2 inches; alder 1/5 to 1/3 of an inch; spruce, Scotch pine, and larch 1/3 to 1/2 of an inch; Austrian pine ½ of an inch; birch and elm as thin as possible (a cover of ½ an inch prevents germination entirely.)

The drills may be covered to advantage with other material than the soil of the seed-bed, such as garden mold mixed with sand, sod-ashes, sawdust, which keep loose and moist and afford additional plant food. The covering material is filled into the drills, heaped full and then pressed down gently (firmed,) to bring seed and soil into close contact, which helps to supply the moisture.

Fall sowings may be covered more heavily. A cover of sphagnum moss, powdered for small seeds, makes an excellent cover, being light and retaining moisture. But care must be taken to make this cover not too thick or to replace it with soil when the seed has geminated, in order to avoid the spindling growth to which the plantlet would be forced through the thick cover.

If the soil is in proper condition, fresh or moist, no watering is required, but if water seems necessary it is better to apply it before sowing.

AFTER-CARE.- During the period of sprouting, which may last from two to four weeks in the average, the only care necessary is to prevent the soil from drying out.

Especially after the seed has begun to swell the supply of moisture must be even and constant. Small seeds naturally dry out more easily than large, and therefore require closer attention. The moisture supply is kept even by watering, or better by covering with mulch, which prevents evaporation, or with lath screens, described further on.

Watering should be avoided as long as possible, but must be resorted to if the soil becomes dry and then must be kept up until rainy weather occurs, since, by watering, the soil becomes packed and liable to dry out more rapidly than before. The watering is best done evenings with a very fine hose. Large seeds require less water, small seeds generally most; except conifers, which can get along with very little. In fact, the greatest care must be taken with these not to give too much water, as the young plants damp off very easily. With the use of shallow boxes the watering can hardly be avoided. Placing the boxes in moist ground will reduce the need of watering.

Covering the ground, or shading, to prevent evaporation is better than watering. This covering or mulching is done right after sowing, and consists of a thin layer of sphagnum moss or cut straw; the shading is done by lath screens or otherwise. If moss or straw is used it is necessary to carefully watch when the seedlings appear and remove the cover at once, to avoid spindling growth of the young plants, and replace it by a side cover of brush stuck alongside the drills. This cover also furnishes pro-

tection against too much cooling off during the night.

But better and more convenient then all these means of protection are the lath screens, a contrivance which facilitates the protection of the seed-bed and the seedlings afterwards so much that nobody should attempt to grow seedlings without them. These consist of a frame of two parallel sticks, or better, pieces of board 5 to 6 inches high and laths 1½ inches apart nailed across. These frames or screens are best made the width of the seed-bed, say 3 feet and any length that is needed, not over 4 feet for convenient handling.. They can be placed directly on the seed-bed, or better, on short poles driven into the ground or on legs, one at each corner, raising the frames 6 to 8 inches above the bed.

The danger of losing the seedlings is greatest after they have appeared above ground and for three to four weeks afterwards. It is then that greatest attention is needed in regulating moisture supplies.

The lath screen does excellent service in regulating the moisture of the soil and the transpiration of the plant, by protecting them from the direct rays of the sun, heat and wind, and keeping the air below the screen cooler and moister. The use of these screens is more or less important in the earlier stages of the life of all seedlings, and with conifers and a few specially tender kinds they are best used the entire first season. They are then gradually raised on poles to 2 or 2½ feet above ground, and at last entirely removed, when the wood is matured.

During rainy or cloudy days and nights the screens are best removed or raised and occasional airing during the hotter parts of the day is needed, especially with conifers. Most deciduous trees soon grow beyond the need of this protection, but yet are benefited by having some side protection, such as a wind-break or wall at some distance or a hedge will furnish.

Watering of seedlings may sometimes become necessary in dry weather.

CULTIVATION.- The soil is kept free from weeds and loose, to absorb moisture and prevent evaporation. Hilling it up along the seedling row is advantageous in keeping them moist, and a mulching between the rows of moss, litter, or even stones, helps to keep down weeds and protects the soil against drying. The pulling of weeds is done in wet weather or after watering and repeated as often as necessary; the last weeding should be done in September. The loosening of the ground not deeper than 1 or 2 inches is best done in dry weather when the soil will crumble, and should not be continued after August, to avoid winter killing of a late, unmatured growth.

The first loosening of beds sown in the fall is best done in spring as soon as all danger of frost is passed. The spring beds are cultivated when the soil under the influence of continued rain followed by heat has packed together; under otherwise favorable conditions cultivation

does not become necessary again more than once or twice during the season.

Protection against frost may become necessary either in the fall or oftener in the spring, even of the second year. The damage done is due to a rapid change of temperature, and, especially, the rapid thawing of frozen parts under the influence of the sun after a cold night, also by the dry cold winds of winter.

To guard against the late frosts of spring sow late in spring; cover fall sowings after the first strong winter frost with mulch to prevent an early start in spring, or place lath screens over the seed-bed, whenever the sky is clear and frost expected. If this has been neglected with plants they may still be saved by watering before sunrise, which retards the thawing; or at least shading against the early morning sun.

The different kinds are liable to frost in a different degree. Oak, beech, fir, chestnut, locust, ash and spruce are more sensitive to late spring frosts than maple, elm, linden; others, like most pines, alder, birch, do not suffer at all or rarely. The time of budding has also some influence with regard to liability to frost; the trees which bud early naturally being more exposed to the danger than those which like oak, ash, and locust bud late.

THINNING.- Lastly, if the seedlings stand too close, as may happen even with the best care in distributing the seed, and almost always if the seedlings are to remain two years

in the seed-bed, it is desirable to thin out the rows, by pulling out from the middle of the drill the weakest plants. This is done either the first summer or in the spring of the next year.

SEEDLING NURSERY.- As a rule, and especially a rule for such climates as that of our western plains and prairies, most seedlings should not be transplanted into permanent sites until two or three years old. They should first be transplanted into plant beds and by proper care fitted for the hardships which they meet in the permanent site. In fact, as has been stated at the outset, that planting is preferable and more economical in the end, than sowing in the permanent site, so it may be stated that using "schooled" or transplanted plants from the nursery is safer and therefore more economical in the end, than planting directly from the seed-bed. The care of plants in the nursery will form the subject of a separate paper.

UNITED STATES DEPARTMENT OF AGRICULTURE

FORESTRY DIVISION

Circular No. 7.

The Government Timber Tests

In reply to many inquiries regarding the comprehensive Timber Tests inaugurated in the Forestry Division of the Department of Agriculture, the following brief statement regarding the objects and methods of the work have been prepared, in the hope that thereby an interest in this investigation, a work of national importance, may be spread.

Need of the Investigation

It will be admitted by all who have to handle wood in building, engineering, and manufacturing, that our knowledge regarding the properties of our various timbers is not very satisfactory, and that while attempts more or less systematic have been made to determine those properties, and knowledge gained from experience exists among those who have handled certain classes of wood for certain purposes, there does not exist much reliable published information for general use.

The reason for this deficiency may be explained from the fact that wood, being a non-homogeneous material,

varies very largely in its qualities. Not only does there exist a wide range of qualities in the same species as if grown under different conditions, but the quality varies in the same tree from the butt to the top, and from the heart to the bark.

To arrive, then, at any satisfactory results in an experimental determination of the properties of the wood, it is necessary to derive them from test material of known origin, and furthermore, to establish any laws which will be generally applicable in referring quality to physical appearance, structure, and origin of material, it is necessary to examine and test carefully a very large number of test specimens.

The difficulty for private enterprises to secure the test material in sufficient quantity, and with a full knowledge of its origin, in fact the magnitude of an investigation of this kind, renders it pre-eminently an undertaking for a Government agency. This has also been recognized by the Prussian Government; but the United States Department of Agriculture can boast of having inaugurated such elaborate work one year earlier.

The object of this work in general will be readily perceived from the foregoing statement.

Besides more reliable data regarding the properties of our principal timbers, there is to be gained from this investigation a means of determining quality by the examination of physical appearance and structure, and of

establishing an inter-relation between quality and conditions of growth.

To define the objects of the work more in detail, some of the questions which it is expected ultimately to solve may be formulated as follows:

What are the essential working properties of our various woods and by what circumstances are they influenced? What influence does seasoning of different degree have upon quality? How does age, rapidity of growth, time of felling, and after-treatment change quality in different timbers? In what relation does structure stand to quality? How far is weight a criterion of strength? What macroscopic or microspopic aids can be devised for determining quality from physical examination? What difference is there in wood of different parts of the tree? How far do climatic and soil conditions influence quality? In what respect does tapping for turpentine affect quality of pine timber?

It is also proposed to test, as opportunity is afforded, the influence of continued service upon the strength of structual material, as for instance of members in bridge construction of known length of service. This series of tests will give more definite information for the use of inspectors of structures.

Besides these problems, many others will arise and be solved as the work progresses, and altogether a wealth of new knowledge regarding one of our most useful materials must result. It is proposed to publish

results from time to time.

Organization and Methods

There are four departments necessary to carry on the work as at present organized, namely:

I. The collecting department.

II. The department of mechanical tests.

III. The department of physical and microscopic examination of the test material.

IV. The department of compilation and final discussion of results.

The collection of the test material is done by experts (Dr. Charles Mohr, of Mobile, Ala., for southern timbers). The trees of each species are taken from a number of localities of different soil and climatic conditions. From each site 5 trees of each species are cut up into logs and disks, each piece being carefully marked, so as to indicate exactly its position in the tree; four trees are chosen as representative of the average growth, the fifthor "check tree" the best developed specimen of the site.

Disks of a few young trees, as well as of limb-wood, are also collected for biological study. The disk pieces are 8 inches in height and contain the heart and sapwood of the tree from the north to the south side of the periphery. From 50 to 70 disk pieces and from 10 to 15 logs are thus collected for each species and site.

A full account of the conditions of soil, climate, aspect, measurements, and determinable history of tree and forest growth in general accompanies the collection from each site.

The disks are sent, wrapped in heavy paper, to the Botanical Laboratory of the University of Michigan, at Ann Arbor (Mr. F. Roth, in charge), to be studied as to their physical properties, their macroscopic and microscopic structure, rate of growth, etc. Here are determined, (a) the specific weight by a hygrometric method; (b) the amount of water and the rate of its loss by drying in relation to shrinkage; (c) the structural differences of the different pieces, especially as to the distribution of spring and summerwood, strong and weak cells, open vessels, medullary rays, etc.; (d) the rate of growth and other biological facts which may lead to the finding of relation between physical appearance, conditions of growth, and mechanical properties.

The material thus studied is preserved for further examinations and tests as may appear desirable, the history of each piece being fully known and recorded.

The logs are shipped to the St. Louis Test Laboratory in charge of Prof. J. B. Johnson. They are stenciled off for sawing and each stick marked with dies, corresponding to sketch in the record, so as to be perfectly identified as to number of tree, and thereby its origin, and as to position in tree. After sawing to size, the test

pieces are stacked to await the testing. One-half of every log will be tested green, the other half after thorough seasoning. A determination is made at the time of testing of the amount of water present in the test-piece, since this appears greatly to influence results.

From each tree there are cut two or three logs, from each log three or four sticks, two of standard size, thh other one or two of larger size. Each standard stick is cut in two, and one end reserved for testing two years later after seasoning. The standard size for the sticks is 4x4 inches and 60 inches long for cross-breaking tests. There will, however, be made a special series of cross-breaking tests on a specially constructed beam machine, gauged to the Watertown Testing Machine, in which the full log length is utilized with a cross section of 6 by 12 up to 8 by 16 inches, in order to establish the comparative value of beam-tests to those on the small test-pieces. It is expected that, in the average, 50 tests will be made on each tree, besides 4 or 5 beam tests, or 250 tests for each species and size. The methods adopted for the tests will be described more fully later.

All due caution will be exercised to perfect and insure the accuracy of methods and besides the records, which are made directly in ink into permanent books, avoiding mistakes in copying, a series of photographs exhibiting the character of the rupture, will assist in the ultimate study of the material, which is also preserved.

The department of compilation and final discussion

of results is as yet not organized.

Conclusion

Such work as this, if done as indicated, and well done, will never need to be done over again. The results will become the standard, the world over. The strength and value of a given species or even stick will then no longer be a matter of opinion, but a question of established fact, and we will learn not only to apply our timbers to the use to which they are best adapted, but also what conditions produce required qualities, thus directing the consumer of present supplies and the forest grower of the future.

The American Association for the Advancement of Science, in its Section of Mechanics and Engineering, has created an Advisory Board to assist in securing improved methods, and the cooperation of other authorities will be welcomed to make this a truly national work.

So far the work has been confined to Southern Pines and Oaks (which, thanks to the courtesy of the Louisville and Nashville Railroad Company, could be obtained free of transportation charges); the scant appropriations available, and other unfavorable conditions, making such limitation necessary.

The work will be extended and its progress pushed in proportion to appropriations made by Congress, which

depend upon the interest, which the work may arouse among those to be benefited by it.

B. E. Fernow,
Chief of Division.

Approved:

Edwin Willits,
Assistant Secretary.

UNITED STATES DEPARTMENT OF AGRICULTURE

FORESTRY DIVISION

Circular No. 8.

STRENGTH OF "BOXED" OR "TURPENTINE" TIMBER.

Among the investigations of timber which for the last six months have been carried on by the Forestry Division as described in circular No. 7, one series of tests was instituted to determine the effect which the practice of gathering resinous matter for the manufacture of turpentine and naval stores from the longleaf pine of the South may have upon the strength of the timber of trees subjected to this practice.

The gathering of resin is done by cutting a recess (box) into the foot of the tree, which is called "boxing" the tree, and then scarring (chipping) the trunk above the box, increasing the size of the scar from year to year. From this scar the semi-liquid resin exudates and drains into the box; this process is continued for four years and then the trees, lessening in yield, are abandoned.

The current public belief has been that the timber of these "boxed" trees, sometimes called "turpentine timber", is deteriorated by the process. Not only is its durability, in which this species excels, believed to be lessened, but also its strength, and hence its

value in the market has been considerably reduced.

Since annually from 500,000 to 750,000 acres of this pine are boxed, involving in this assumed deterioration, at the lowest estimate, 1,000,000,000 feet, B. M., of lumber, a considerable loss in values, counting by millions of dollars, is thereby incurred.

As far as durability is concerned, there seems little doubt that the withdrawal of the resinous matter, which furnishes protection against the penetration of water and seems also to have antiseptic properties, reduces the capacity to withstand rot at least in some parts of the tree; the portion near the scar, where the resin accumulates, of course becomes more durable. But it did not seem reasonable that the strength in general should suffer. The tests conducted in the test laboratory at St. Louis, in charge of Prof. J. B. Johnson, give countenance to the important conclusion, that "turpentine" timber seems to possess greater strength than timber from unboxed trees.

Although the tests and examinations of this series are not yet completed, and further study will perhaps necessitate modifications of this general statement, the economic importance of the discovery seemed to call for immediate preliminary publication, especially since the investigation had to be interrupted for lack of funds and may, therefore, not be continued for some time, delaying verification and fuller conclusions.

A detailed account of the experiment will be published later, when tests and examinations are fully completed. It is here intended only to give the basis upon which the above conclusion is stated.

The test material was collected at Wilson's Station, Alabama, consisting of 8 trees which had been boxed and abandoned five years, and 11 trees which had been worked for the last time during the past season. These trees furnished, besides some 50 disks for physical examination, 20 logs for tests. From these 115 test pieces for each kind of test were prepared. For comparison 40 logs from 11 unboxed trees collected at Wallace and Thomasville, Alabama, furnished 133 test pieces for each kind of test.

It having been established as a law that strength changes with the amount of seasoning, it became necessary to establish the ratio of change due to seasoning in the boxed timber (which had been tested green), by special tests on 25 sticks taken from corresponding positions in the tree which were seasoned. Then the tests on all the green sticks were corrected for 20% moisture, corresponding to the moisture percentage of the unboxed timber. The results are exhibited in condensed form in the accompanying table.

Since among the boxed specimens there were quite a number from higher positions in the tree than those of the boxed specimens, which were mainly taken at a height of 7 to 33 feet above ground, a selection was made of the results of 15 tests made on sticks of nearly like position and diameter

of tree, both boxed and unboxed. In this comparison the numerical value of the difference is naturally reduced, but not the general tendency, namely, to show that "turpentine" timber, while exhibiting less tensil and shearing strength, is stiffer than that from unboxed trees and has greater compressive and cross-breaking strength. At the same time it may be stated that turpentine timber proved itself harder to work, the resin collecting in spots gumming up the tools.

The possibility of flaws in experiments of this kind makes it proper to caution against full acceptance of the results until further verified. Especially is it desirable to extend the investigations into the higher portions of the tree, for while no deterioration seems to take place near the scar of the tree, perhaps because the resinous juices are drained in that direction, it is possible that the wood of the higher portions of the tree may be changed, either for worse or for better. There has not been time yet to study the physical changes which have taken place in the different parts of the tree due to the boxing.

We feel, however, justified to maintain that the claimed inferiority of turpentine timber in strength does not exist.

Information regarding authenticated cases of practical observation on this point is solicited by the Division.

B. E. Fernow,
Chief of Division.

Approved:
Edwin Willits,
Assistant Secretary.

	Specific Gravity.	Per cent. Moisture.	Tensile Strength	Comparative strength end-wise.
"Boxed" Timber:			Lbs. per sq. in.	Lbs. per sq. in.
25 sticks "green"	.759	30.91	15,448	4,755
25 sticks "dry"	.687	18.91	14,757	6,627
Percentage of change	-9.5	-39.	-4.2	+39.4
Percentage of change to reduce to 20% moisture	-8.5	- 3.5	-3.8	+35.5
Mean of 115 tests	.76	30.9	15,985	5,118
Corrected for 20% moisture	.696	20.0	15,485	6,985
"Unboxed" Timber:				
Mean of 133 tests	.710	20.0	16,429	5,661
Excess of "boxed" over "unboxed" timber	-.014	0.0	-.944	+1,274
Excess "boxed" over "unboxed", per cent	-2.0	0.0	-5.7	+22.5

Cross-breaking strength.	Modulus of elasticity.	Elastic Resilience.	Comperative strength across grain.	Shearing strength
Lbs. per sq. in.	Lbs. per sq. in.	In lbs. per cu. in.	Lbs. per sq. in.	Lbs. per sq. in.
8,709	1,566,400	1.73	680	540
11,350	1,644,360	2.71	1,064	648
+30.1	+4.9	+56.6	+56.5	+20.0
+27.0	+4.4	+51.0	+51.0	+18.0
8,988	1,623,000	1.83	743	539
11,118	1,694.000	2.76	1,122	636
9,333	1,800,000	1.92	855	652
+1,785	-106,000	+.84	+267	-16
+19.2	-5.9	+48.8	+31.2	-2.4

UNITED STATES DEPARTMENT OF AGRICULTURE

FORESTRY DIVISION

Circular No. 9.

EFFECT OF TURPENTINE GATHERING ON THE TIMBER OF LONGLEAF PINE.

IN Circular 8 of the Forestry Division, published about a year ago, it was stated that tests made on timbers of Longleaf Pine, bled or unbled, lent countenance to the belief that bled or tapped timber did not suffer in strength by virtue of the tapping. Further tests and examinations permit now the announcement without reserve that the timber of Longleaf Pine is in no way affected by the tapping for turpentine. This refers to its mechanical as well as chemical properties, and hence even the reservation that it might suffer in durability is now eliminated and any prejudice against the use of bled timber in construction, wherever the unbled timber has been considered desirable, must fall as having no foundation in fact, being based only on vague belief, proved to be erroneous.

It is to be hoped that this fact will be made widely known among builders, architects, and engineers who have hitherto made discrimination against bled timber and thereby depreciated or discouraged the manufacture and impeded the sale of an article which answers all the purposes of construction and the unrestricted use of which is dictated by true economy.

The basis for the statement regarding the mechanical properties is furnished by a series of tests comprising not less than 500 tests on 32 trees of this Pine, bled and unbled, from various localities.

The somewhat puzzling fact that bled timber exhibited, if anything, greater strength in the tests has been accounted for by the fact that the turpentine orchards are located mostly on sites which produce better quality timber as well as larger yield of turpentine.

To determine whether any changes in the chemical composition take place, a series of chemical analyses of bled and unbled timber has been made, which indicates that the resinous contents of the heartwood are in nowise affected by the bleeding, the oleoresins of the heartwood being non-fluid, the whole turpentine flow is confined to the sapwood.

Among other interesting facts regarding the distribution of resinous contents through the tree which will be published in a separate bulletin, it appears that trees standing side by side and to all appearances in similar conditions show very varying quantities of resinous contents.

To make sure that experience did not, if sifted down, contradict the results of these investigations, a competent agent, Mr. F. Roth, visited turpentine orchards and sawmills in the Longleaf Pine region. He reports that no-

body was found - although it was claimed by some - able to discern any difference in the appearance of the bled and unbled timber; that in spite of consumers' specifications for unbled timber, they are almost invariably served with a mixture without finding it out; that experience in the districts where bled timber is cut and used has not sustained the claim of inferiority.

This information is furnished in advance of the full report on the investigations in question, in order to remove as quickly as possible the unwarranted discrimination against the product of nearly one million acres of Southern pine, which are annually added to the total acreage in turpentine orchards.

This result of authoritative investigation should be worth several million dollars to the forestry interests of the South, permitting readier use and sale for a product that left uncut endangers the future of the forest by the destructive conflagrations to which it is specially subject.

B. E. Fernow,
Chief of Division.

Approved:

Edwin Willits,
Assistant Secretary.

Circular No. 14.

UNITED STATES DEPARTMENT OF AGRICULTURE
Division of Forestry.

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IS PROTECTION AGAINST FOREST FIRES PRACTICABLE?

It has been claimed by many lumberman and others that the burning of the tops, slashings, or debris thus resulting from their operations would be a "hardship", "too expensive", "impracticable", and that it is impossible to avoid or decrease the forest fires which we have to endure every year like a natural phenomenon.

There is now actual experience at hand showing that none of these claims can be sustained; that it is possible to protect large areas against fire; that it is possible, practicable, simple and cheap to burn the debris in a lumberman's choppings.

In support of the first proposition we need only to quote from the Report of the Commissioner of Crown Lands of the Province of Ontario for 1895 regarding the working of the plan of forest-fire protection proposed by the American Forestry Association in 1882.

In explanation it should be stated that in Canada the forest growth is mostly owned by the Crown, the timber alone is sold in so-called limits; the cut from which equals now over 800,000,000 feet, B. M., bringing a net revenue to the Government of over $700,000.

The report is as follows:

Fire Ranging.

The total cost of this service for last year was $26,253.81, of which $12,080.82 was refunded by licensees, leaving the net expenditure $14,172.99.

The fire ranging system was established in 1886. Its provisions are briefly as follows: The placing of a number of men during the dangerous period of the summer, say from May to the end of September, on licensed and unlicensed lands of the Crown, where, from settlement, railway construction, lumbering, or any other cause, fire is so frequently used as to be a source of danger. The number of men necessary to give the proper protection is left to the owners of the limits, who are familiar with the topography, exposed position of the limit, etc., and they are also allowed to nominate or select the men to be employed, the department reserving the right to reject or remove any man whom it believes to be unfitted for his duties or who neglects his work. These men are instructed by the department and are, under section 14 of the fire act, officers for the enforcement of the provisions thereof. They are supplied with large posters of the fire act and pamphlet copies of the same, and are instructed to put up the posters in public and conspicuous places throughout the territory under their charge, and to hand pamphlet copies to settlers and others, so that they may have an opportunity of becoming acquainted with the provisions of the law and have no excuse for not obeying it. They are authorized to engage assistance should fires break out, and should these assume large and dangerous proportions they are required to notify the licensee and the department, in order that both may be represented on the spot should that appear necessary. The department bears half of any expense incurred in suppressing fires, as well as half of the wages of the fire rangers, whose remuneration is fixed at $2 per day, out of which they have to defray their board, etc. At the end of the season they are required to send in their diaries and sworn accounts and a report upon the fires which occurred, together with the loss, etc.

The past summer was one of the driest for years, particularly in the country lying east of Sault Ste. Marie, and the experiences of the rangers in this respect are borne out by the reports of the various meteorological stations. * * * As a consequence of the very dry and hot character of the summer there had to be a closer watch maintained everywhere, and in certain specially dangerous and exposed regions the staff had to be strengthened beyond what has been customary in an ordinary year, and in one or two instances where large fires occurred in outlying districts a staff had to be sent to the spot to fight the fire. I am glad, however, to be able to say that, owing no doubt in a great measure to the close supervision and systematic organization which existed, no

large destruction of timber took place. The only fire of any consequence which occurred on unlicensed territory was in the township of Grant, where a considerable quantity of pine was so badly damaged as to render a sale of it advisable, so that it might be cut and not go to waste. The reports show that 46,556,000 feet of pine were damaged, and the estimated loss was $38,450. Some of the licensees were unable to put a value on the damaged timber, but as nearly all were aware early in the season of the extent of the fires and the localities in which they occurred, they have made preparations to cut the timber, and the actual loss, therefore, will probably not be great. The chief causes of the fires seem to be the clearing of land by settlers and the carelessness of camping and hunting parties. It is customary to ask the licensees each year to point out any defect in the system and to make any suggestions by which they think it could be improved, but with the exception of a desire to make the keeping of fire rangers on limits in the summer time obligatory instead of optional there is no suggestion of amendment. They all seem to think that the service is admirably adapted to accomplish the object for which it was established.

As to the practicability of burning the debris of lumbering operations, the following letters of H. M. Loud and Sons Lumber Company, located at Au Sable, Mich., will be convincing:

We have always made it a practice in our lumbering whenever possible to burn the debris in the fall or in the spring when the ground is somewhat damp, so that fires will not spread and when the wind is in the right direction. This has been a very successful method with us, as we have escaped in all the years that we have lumbered here from any destructive forest fires and we believe that had we not taken the precautions, our losses would have been enormous.

The open chopping dries out much more quickly in the spring than the neighboring timbered land; consequently the fire will burn in the open and stop as soon as it comes to the timber, and we have never yet had any difficulty in confining the fire to the desired limits. It only requires common sense or good judgment to know when the proper time is to burn the choppings and so cover this menace to our uncut timber.

And the following dated April 18, 1896:

I have just returned from our lumbering operations which are at present in the southern part of Montmorency County, 70

miles distant, and noticing on my arrival there that the conditions were just right for burning, I had the fires started at once in our choppings, and in two days we had burned over our choppings in that locality.

The method which I pursued was to send out four men with torches pearly like those used for campaign purposes, holding about a quart of kerosene oil, with ordinary candle wicking, and with these torches they can go rapidly from pile to pile of debris, setting fire very rapidly and covering a large territory. The piles were dry enough to burn very freely, but the ground was somewhat damp and fires would die down as soon as they reached the limits of the chopping. For the ground covered, the expense would not exceed $10, burning over probably 2 square miles.

The timber surrounding this chopping just burned over amounts to probably 100,000,000 feet, worth $500,000 and stands very thick, averaging about 600,000 to 1,000,000 feet to the 40 acres. We now feel very safe for the summer in working in this green timber, as the fires can not come in on us from the choppings of last year.

Michelson Hanson Lumber Company of Lewiston, our neighbors in that locality, follow the same method with the same results. This burning over is a very good insurance and, as you can see, the small amount it costs is money well expended and, in fact, we consider it would be criminal carelessness on our part if by this watchfulness we did not guard against the losses in the interests of our neighbors.

It may be added that it is the practice in well-conducted lumber camps to pile together as much as possible of the brush and tops remaining from the operations of the log cutter, so that a number of small heaps of brush are scattered through the woods. These dry out faster than the litter on the ground, and can be burned at the proper time with little danger of spreading the fire. It would be impracticable and expensive to move these brush heaps, as has been suggested, but as shown above they can be burned where they lie with a minimum of damage and least expense.

The Cost.

It will be observed that in Ontario the cost of the protective service was equal to 3½ cents per thousand feet harvested, while for the lumber companies' burning of the debris $5 per square mile is estimated, which may be calculated to represent a tax of one-tenth of a cent per thousand feet of choppings. Even if we increase this figure to one-fourth of a cent per thousand feet, B. M., placing the cut of the three great lumber States, Michigan, Wisconsin and Minnesota,- at round 13,000,000 thousand feet, it would appear that an expenditure of less than $35,000 would obviate a large amount of the terrible loss which counts up into millions of dollars annually. And if to this precaution be added a service similar and at the same expense as that so successfully carried on in Ontario, the cost to the three states would be less than $450,000. Compared with the annual fire loss even this extravagant sum would be a small matter; we are inclined to believe that much less than $100,000 for each State, properly spent with a well-organized service of specially employed forest guards, would obviate nearly all the forest fires.

We would call special attention to the wisdom and thoroughly democratic spirit of the Canadian system, which gives to the parties most interested in protecting their property a voice in the selection of the guards.

As shown in Circular 13 of this Division, organization based on political lines is attempted by the recent legislation

in several States, notably Maine, Wisconsin and Minnesota. While this is an advance upon the conditions hitherto existing, the apparent attempt of cheapening the service, of getting something for nothing, or nearly so, it is to be feared, will largely depreciate the effectiveness of the legislation.

The kind of organization attempted by this legislation is largely of the same sort, as that of the old city and village fire engine companies, which relied entirely upon voluntary exertions, and is now happily superseded by a paid service. In the same way nothing short of a specially organized and paid fire service will be entirely satisfactory in preventing and checking forest fires.

To get a conception as to what is really lost in these forest fires and to show how insignificant in comparison to the result the expenditure of such a sum for protection would be the following computation by the Forest Commissioner of Pennsylvania is quoted:

> The most obvious consequences of forest fires, serious as these may be, are by no means of the greatest importance. Loâs of logs, of bark, of standing timber, young and old, of fences, and occasionally of buildings, is, as stated elsewhere, not less than a million dollars annually to this Commonwealth (Pennsylvania). This might well enough be termed a direct loss to the State. The indirect or the consequential damage to the State is many times greater. In fact, it is so great that it appears incredible until a careful study of the whole subject is made. For example, it is fairly within bounds to assert that with all the unproductive lands now vacant and uncarâd for which exist within the limits of the State were protected from forest fires, for say forty years, the timber then growing would be worth not less than $1,200,000,000. Now it would seem that if this growth were destroyed by fire when but

a year old, the direct loss to the Commonwealth would be absolutely unimportant. The same might be said if we were to see it destroyed at two, three, four, or even five years of age. But when we remember that in burning these seedlings, which are but a year old, we destroy a crop, which in point of time is one-fortieth of its way on to a money value of $1,200,000,000, the damages are consequential or indirect in chargeter, and if expressed in figures, must equal not less than $30,000,000 as the loss to the Commonwealth.

To be sure, forest fires can probably not be altogether prevented by any system, but they can be reduced to a minimum.

Regarding the use of spark arresters for locomotives, see Bulletin I, Forestry Division; regarding the making of fire lanes, safety strips along railroad tracks, and other means of protection, see Report of Forestry Division for 1892.

B. E. FERNOW
Chief of Division of Forestry.

Approved:

J. STERLING MORTON
Secretary of Agriculture.